

Michigan

PROCEEDINGS

OF THE

LAKE SUPERIOR MINING INSTITUTE

INCLUDING THE MINUTES

OF THE

INAUGURAL MEETING

MARCH, 1893

PUBLISHED BY THE INSTITUTE.

PROCEEDINGS

OF THE

LAKE SUPERIOR MINING INSTITUTE

INCLUDING THE MINUTES

OF THE

INAUGURAL MEETING

MARCH, 1893

PUBLISHED BY THE INSTITUTE.

PRINTED AND BOUND BY
DARIUS D. THORP
LANSING, - MICHIGAN.

OFFICERS OF THE
LAKE SUPERIOR MINING INSTITUTE.

Elected March 23d, 1893.

PRESIDENT.

	Term of Office.
NELSON P. HULST, - - - - -	1 year

VICE-PRESIDENTS.

JOHN T. JONES, - - - - -	2 years
F. P. MILLS, - - - - -	2 years
GRAHAM POPE, - - - - -	2 years
M. W. BURT, - - - - -	1 year
J. PARKE CHANNING, - - - - -	1 year

MANAGERS.

W. FITCH, - - - - -	2 years
JOHN DUNCAN, - - - - -	2 years
J. McNAUGHTON, - - - - -	1 year
CHAS. MUNGER, - - - - -	1 year
WM KELLY, - - - - -	1 year

TREASURER.

C. M. BOSS, - - - - -	1 year
-----------------------	--------

SECRETARY

F. W. DENTON, - - - - -	1 year
-------------------------	--------

The above officers constitute the Council.

P R E F A C E .

The following circular letter was issued February 11th, 1893, by Mr. William Kelly of Vulcan, Michigan, and sent by him to all gentlemen known to be interested in mining in the Lake Superior districts, whose addresses could be obtained:

Mr.

.....

.....

DEAR SIR—At a social meeting of a number of mining men of the Menominee and Gogebic ranges, held at Ironwood, February 2, the subject of an association of all persons interested in mining on Lake Superior was discussed and a resolution adopted, that an effort be made to organize an association with the object of promoting social intercourse, and affording an opportunity for an interchange of views. It was also embodied in the resolution, that an invitation be extended to the mining men of all the districts of the Lake Superior region, to assemble at Iron Mountain, on March 22, 1893, at 8 o'clock p. m., to effect an organization.

We would heartily ask your co-operation in this matter, and request that you invite to this meeting all whom you think likely to be interested.

Yours truly,

WILLIAM KELLY,

VULCAN, MICH., February 11, 1893.

Secretary.

This letter was received with universal approval, and the gathering which resulted at Iron Mountain was a large and representative one. There were one hundred and sixty gentlemen in attendance.

The incidents, which led to the issuing of the above letter, and the history of the final organization of the Institute, are clearly brought out in the minutes of the several meetings.

F. W. DENTON,

Secretary.



Digitized by the Internet Archive
in 2017 with funding from

This project is made possible by a grant from the Institute of Museum and Library Services as administered by the Pennsylvania Department of Education through the Office of Commonwealth Libraries

CONTENTS.

	PAGE.
Minutes of the meeting of March 22d	1
Minutes of the meeting of March 23d	5
Rules of the Institute	5
Excursions	12
Soft Ore Mining on Lake Superior, by Per Larsson, Superintendent Aragon Mine, Michigan	13
The Geology of that Portion of the Menominee Range, East of the Menominee River, by Nelson P. Hulst, of Milwaukee	19

MINUTES OF THE MEETING OF WEDNESDAY
EVENING, MARCH 22, 1893.

MR. MASON W. BURT, Chairman, having called the meeting to order, said:

“This is an adjourned meeting of a few gentlemen from the Gogebic and Menominee Ranges that met a few weeks ago in Ironwood. I think that meeting was instigated by the visitors from this district, and they will be entitled to a large portion of credit for any benefits which we derive from the organization which is about to be formed. There are a good many present here now, of course, that were not then, from all the ranges, and as temporary chairman, chairman of that meeting and temporary chairman of this, I would welcome all of the strangers here on the behalf of those present at the Ironwood meeting, but particularly in behalf of the Menominee gentlemen who were there with us at that time.”

“Will the secretary please read the minutes of that meeting.”

Minutes read by Mr. Kelly, Secretary, as follows:

“At a meeting of mining men from the Menominee and Gogebic Ranges, held at Ironwood, February 2, 1893, Mr. Oleott called the meeting to order and nominated Mr. Burt for chairman, who was elected. Mr. Kelly was elected Secretary. After remarks made on the subject, on motion it was agreed, that a committee of five be appointed to report to this meeting a call for a meeting at a certain time and place for the general purpose of forming an organization of the mining men of the Lake Superior mining region. The Chair appointed Messrs. Brown, Day, Boss, McNaughton and Larsson. After a recess the Committee submitted a circular letter and recommended that the Secretary be directed to send the same to the mining men of the other ranges. The report was adopted. After further discussion of the object and advantages of an organization, the minutes were approved and the meeting adjourned, to meet at Iron Mountain, March 22nd.

Those present at this meeting were:

Geo. H. Abeel,	James H. Goudie,	W. J. Olcott,
R. Bawden,	John C. Harris,	C. H. Phelps,
C. M. Boss,	J. H. Harding,	E. J. Roberts,
E. F. Brown,	John K. Hooper,	Harry Roberts,
J. S. Buddle,	E. P. Jennings,	N. B. Roscorla,
D. R. Bundy,	William Kelly,	Frank Scadden,
Mason W. Burt,	Will K. Knight,	H. B. Sturtevant,
R. H. Channing, Jr.,	Per Larsson,	D. E. Sutherland,
John P. Christopher,	N. O. Lawton,	Edw. Sweeny,
Wm. Corbett,	Jas. McNaughton,	J. H. Taylor,
O. C. Davidson,	D. McVichie,	Wm. Trebilcock,
J. D. Day,	Pentecost Mitchell,	James Trezona,
C. M. Fitzsimmons,	C. H. Munger,	Arthur A. Wakefield,
	M. P. O'Brien,	

MR. BURT—"The purpose of this organization will be to discuss things pertaining to the mining of ores and minerals of different kinds in the Lake Superior district, which will include very largely, as we all know, iron and copper, and it is also the purpose to have many practical as well as scientific men members of the organization; and I was glad to see at the hotel today, that we had representatives from all the districts and from all professions. We have two professors from the Houghton Mining School. We have a register here, I think it is ready, and all who would like to join, and become members of the organization, we would like to have register."

MR. KELLY—"The excursion of the Menominee gentlemen to Ironwood was not proposed for the purpose of forming this organization. A few of us had decided that it would be pleasant to go there some time during the winter to relieve the monotony of our work by looking over the Gogebic Range and learning something of the underground methods in use. Shortly after, Mr. Channing's letter appeared in the newspapers, calling our attention to the fact, that seems from this gathering to have been generally realized, that we ought to have an association. The suggestion was made, that we might immediately take it upon ourselves to call a meeting at Ironwood. But not wishing to rush the matter too hastily, we decided to carry out our original plan and during our visit ascertain the feeling of the Gogebic mining men in regard to organizing. So we went up, and were more than pleased with the reception given

us. The meeting was held, of which you have heard the minutes, and in answer to the call we have met here tonight."

"I know no particular reason why our first meeting should be held on the Menominee Range. This is not the oldest mining district. It is not the youngest. It is not even the next to the oldest or the next to the youngest. As far as age goes we unquestionably hold a medium position. To interest you, we have not the basin of the Marquette Range, or the dykes of the Gogebic. We have nothing so euphonious as amygdaloid, and our ash beds are a bye product. We are even without taconite, and instead can only show you an inexhaustible quantity of pure, unadulterated, unvarnished jasper. Unlike some other ranges we do not measure our ore bodies by the half mile in length, or the forty acre tract in area. Our greatest dimension, I am sorry to say, is in depth. If there is anything to which we may lay exceptional claim, it is the amount of water in our mines. If the truth were told I fear the output of ore would bear a poor comparison to the amount of water we hoist. We are free to confess, that we take neither pride nor pleasure in this, but there will be an opportunity tomorrow to see some of the ways we have been trying to solve the water problem. Lately some of our Gogebic friends have been trying to rival us in the output of water, but it relieves us to learn that they have not yet succeeded."

"From the local committee of arrangements, what we have to offer is a hearty welcome, with the hope that you will all have a pleasant and profitable time, and that this meeting may be the first of a long series, that will benefit those who attend, and indirectly the whole Lake Superior region."

Moved and carried: That those present, interested in the mineral resources of, or residents of the Copper Country, assemble separately and select two of their number to serve as members of a committee on permanent organization. That in like manner two each be selected to represent the Marquette, Menominee, Gogebic and Minnesota Iron Ranges respectively: And that these ten constitute a committee whose duty it shall be to report to this assembly tomorrow evening a form of organization.

Moved and carried: That those present interested in the mineral resources of, or residents of the Copper Country, assemble separately and select two of their number to serve as members of a committee

on permanent officers. That in like manner two each be selected to represent the Marquette, Gogebie, Menominee and Minnesota Iron Ranges respectively; and that these ten constitute a committee whose duty it shall be to nominate permanent officers in accordance with the form of organization to be reported by the committee on permanent organization.

Moved and carried: That the convention take a recess to permit the selection of representatives from the different districts to serve on the committees in accordance with the motions just carried, and to allow those present to register.

THE CHAIRMAN—"This register is for the sole purpose of furnishing a list of those present, and does not necessarily make those who sign members of any organization, for the organization is not yet formed. The permanent organization will be formed tomorrow evening."

Recess declared by the chairman.

Upon calling the meeting to order after the recess, the following committees were announced:

On Permanent Organization.

F. P. Mills,	William Kelly,
G. H. Abeel,	Edgar Kidwell,
F. F. Cole,	Harry Roberts,
J. A. Crowell,	Frank Scadden,
F. W. Denton,	H. B. Sturtevant.

On Permanent Officers.

F. W. Denton,	D. T. Morgan,
C. M. Boss,	John J. Jones,
E. E. Brewster,	Edgar Kidwell,
O. C. Davidson,	James McNaughton,
W. Fitch,	D. McVichie.

The business of the meeting having been finished, the chairman introduced Mr. Per Larsson, superintendent of the Aragon Mine, Michigan, who read a paper entitled, "Soft Ore Mining on Lake Superior." After the reading and discussion of this paper, and the announcements of the program for Thursday, the meeting was adjourned until Thursday evening.

MINUTES OF THE MEETING OF THURSDAY
EVENING, MARCH 23, 1893.

After calling the meeting to order Mr. M. W. Burt, Chairman, introduced Dr. Nelson P. Hulst, who read a paper entitled, "The Geology of that Portion of the Menominee Range, East of the Menominee River."

After the presentation of this paper, the committee reports were called for.

The committee of permanent organization submitted the following report:

RULES OF THE LAKE SUPERIOR MINING INSTITUTE.

I.

OBJECTS.

The objects of the Lake Superior Mining Institute are, to promote the arts and sciences connected with the economical production of the useful minerals and metals in the Lake Superior region, and the welfare of those employed in these industries, by means of meetings for social intercourse, by excursions, and by the reading and discussion of practical and professional papers, and to circulate, by means of publications among its members, the information thus obtained.

II.

MEMBERSHIP.

Any person interested in the objects of the Institute is eligible for membership.

Honorary members, not exceeding ten in number, may be admitted to all the privileges of regular members except to vote. They must be persons eminent in mining or sciences relating thereto.

III.

ELECTION OF MEMBERS.

Each person desirous of becoming a member shall be proposed by at least three members, approved by the council, and elected by

ballot at a regular meeting (or by ballot at any time conducted through the mail, as the council may prescribe) upon receiving three-fourths of the votes east. He shall become a member on the payment of his first annual dues within ninety days of the notification of his election.

Each person proposed as an honorary member shall be recommended by at least ten members, approved by the council, and elected by ballot at a regular meeting (or by ballot at any time conducted through the mail, as the council may prescribe), on receiving nine-tenths of the votes east.

IV.

WITHDRAWAL FROM MEMBERSHIP.

Upon the recommendation of the council any member may be stricken from the list and denied the privilege of membership, by the vote of three-fourths of the members present at any regular meeting, due notice having been mailed in writing by the secretary to him.

V.

DUES.

The dues of members shall be five dollars, payable upon their election, and five dollars per annum thereafter, payable in advance at or before the annual meeting. Honorary members shall not be liable to dues. Any member not in arrears may become a life member by the payment of fifty dollars at one time, and shall not be liable thereafter to annual dues. Any member in arrears may, at the discretion of the council, be deprived of the receipt of publications or be stricken from the list of members when in arrears for six months; PROVIDED, that he may be restored to membership by the council on payment of all arrears, or by re-election after an interval of three years.

VI.

OFFICERS.

There shall be a president, five vice-presidents, five managers, a secretary and a treasurer, and these officers shall constitute the council.

VII.

TERM OF OFFICE.

The president, secretary and treasurer shall be elected for one year and the vice-presidents and managers for two years, except that at the first election two vice-presidents and three managers shall be elected for only one year. No president, vice-president or manager shall be eligible for immediate re-election to the same office at the expiration of the term for which he was elected. The term of office shall continue until the adjournment of the meeting at which their successors are elected.

Vacancies in the council, whether by death, resignation, or the failure for one year to attend the council meetings, or to perform the duties of the office, shall be filled by the appointment of the council, and any person so appointed shall hold office for the remainder of the term for which his predecessor was elected or appointed; PROVIDED, that such appointment shall not render him ineligible at the next election.

VIII.

DUTIES OF OFFICERS.

All the affairs of the Institute shall be managed by the council, except the selection of the place of holding regular meetings.

The duties of all officers shall be such as usually pertain to their offices, or may be delegated to them by the council.

The council may in its discretion require bonds to be given by the treasurer, and may allow the secretary such compensation for his services as they deem proper.

At each annual meeting the council shall make a report of proceedings to the Institute, together with a financial statement.

Five members of the council shall constitute a quorum; but the council may appoint an executive committee, or business may be transacted at a regularly called meeting of the council, at which less than a quorum is present, subject to the approval of a majority of the council, subsequently given in writing to the secretary and recorded by him with the minutes.

There shall be a meeting of the council at every regular meeting of the Institute, and at such other times as they determine.

IX.

ELECTION OF OFFICERS.

Any five members, not in arrears, may nominate and present to the secretary over their signatures, at least thirty days before the annual meeting, the names of such candidates as they may select for offices falling under the rules. The council, or a committee thereof duly authorized for the purpose, may also make similar nominations. The assent of the nominees shall have been secured in all cases.

Not less than two weeks prior to the annual meeting, the secretary shall mail to all members not in arrears a list of all nominations made, and the number of officers to be voted for in the form of a letter ballot. Each member may vote either by striking from or adding to the names upon the list, leaving names not exceeding in number the officers to be elected, or by preparing a new list, signing the ballot with his name, and either mailing it to the secretary, or presenting it in person at the annual meeting.

In case nominations are not made thirty days prior to the date of the annual meeting for all the offices becoming vacant under the rules, nominations for such offices may be made at the said meeting by five members not in arrears, and an election held by written or printed ballot.

The ballots in either case shall be received and examined by three tellers, appointed at the annual meeting by the presiding officer; and the persons who shall have received the greatest number of votes for the several offices shall be declared elected. The ballots shall be destroyed, and a list of the elected officers, certified by the tellers, shall be preserved by the secretary.

X.

MEETINGS.

The annual meeting of the Institute shall be held on the first Wednesday of March, and a fall meeting shall be held on the first Wednesday in September. The Institute may at a regular meeting select the place for holding the next regular meeting. If no place is selected by the Institute, it shall be done by the council.

Special meetings may be called whenever the council may see fit;

and the secretary shall call a special meeting at the written request of twenty or more members. No other business shall be transacted at a special meeting than that for which it was called.

Notices of all meetings shall be mailed to all members, at least thirty days in advance, with a statement of the business to be transacted, papers to be read, topics for discussion and excursions proposed.

No vote shall be taken at any meeting on any question not pertaining to the business of conducting the Institute.

Every question that shall properly come before any meeting of the Institute, shall be decided, unless otherwise provided for in these rules, by the votes of a majority of the members then present.

Any member may introduce a stranger to any regular meeting; but the latter shall not take part in the proceedings without the consent of the meeting.

XI.

PAPERS AND PUBLICATIONS.

Any member may read a paper at any regular meeting of the Institute, provided the same shall have been submitted to and approved by the council, or a committee duly authorized by it for that purpose prior to such meeting. All papers shall become the property of the Institute on their acceptance, and with the discussion thereon, shall subsequently be published for distribution. The number, form and distribution of all publications shall be under the control of the council.

The Institute is not, as a body, responsible for the statements of facts or opinion advanced in papers or discussions at its meetings, and it is understood, that papers and discussions should not include personalities, or matters relating to politics, or purely to trade.

XII.

AMENDMENTS.

These rules may be amended by a two-thirds vote taken by letter ballot in the same manner as is provided for the election of officers by letter ballot, provided that written notice of the proposed amendment shall have been given at a previous meeting.

Moved and carried: That the rules as read be accepted and adopted by the convention.

The committee on Permanent Officers then reported the following nominations:

President.

NELSON P. HULST.

Vice-Presidents.

John T. Jones,	-	-	-	-	-	-	-	2 years.
F. P. Mills,	-	-	-	-	-	-	-	2 years.
Graham Pope,	-	-	-	-	-	-	-	2 years.
M. W. Burt,	-	-	-	-	-	-	-	1 year.
J. Parke Channing,	-	-	-	-	-	-	-	1 year.

Managers.

W. Fitch,	-	-	-	-	-	-	-	2 years.
John Duncan,	-	-	-	-	-	-	-	2 years.
J. McNaughton,	-	-	-	-	-	-	-	1 year.
Chas. Munger,	-	-	-	-	-	-	-	1 year.
Wm. Kelly,	-	-	-	-	-	-	-	1 year.

Treasurer.

C. M. BOSS.

Secretary.

F. W. DENTON.

After some preliminary remarks it was moved and carried: That the secretary of this meeting cast one ballot for the officers nominated by the committee, and that said officers shall constitute the first officers and council of this association.

The chairman then appointed a committee of three to escort Dr. Hulst to the chair, who upon assuming the office of President said:

“I feel particularly pleased to think that you have thought me worthy of this office. I consider it a very high office. I know I have the good interest of the association at heart as much as any of you. I think we can all profit by meeting together, hearing what each has to say in his particular department, each gaining good knowledge from the other, and if we go on in this spirit I am sure the object of the association will be fully met, and we will be benefited very greatly.”

MR. FITCH—“Mr. President, on behalf of the Marquette delegation, as representing the Marquette district, I wish to extend a

cordial invitation to this Institute to have its next meeting in Marquette county."

After some preliminary discussion with regard to the advisability of leaving the selection of the next meeting place to the council, it was moved by Mr. O. C. Davidson, and carried: That the September meeting of this Institute be held at Ishpeming.

A motion was then made by Mr. Boss and carried: That the rules of the Institute be temporarily suspended, and that all those persons, whose names are upon the register, together with those present who may sign after being given an opportunity to do so, shall be considered eligible for membership; and that the secretary be instructed to notify these persons of their eligibility to membership, and also of the fees necessary to be paid by them.

MR. CHANNING—"Mr. President, I move that the rule as read by the secretary be temporarily suspended, and in addition to those already made eligible by Mr. Boss's motion, that those persons, who have signified to the temporary secretary their desire to become members of the association, and that all persons who are included in the first invitations for the call to this meeting, be also considered as applicants for members of the Institute, and that the secretary send notice to them as well as to those members mentioned in Mr. Boss's motion."

The motion was seconded.

MR. BROWN—"Mr. President, there were some six hundred invitations sent out. I would say that I think Mr. Channing's motion better be defeated."

MR. CHANNING—"Mr. President, in defense of my motion I would say, that there is no objection to the members being limited, but out of those six hundred invited to be present, I think those men ought to be given abundant opportunity to join the Institute, who were unable to accept. There are a great many men to whom those invitations were sent whose work was such that they could not come here."

MR. KELLY—"Mr. President, as a general rule I am very much opposed to suspending rules and regulations, but the proposition to elect all those to whom invitations have been sent, is I think exceedingly desirable. The success of the Institute is going to

depend quite largely upon the extent of our membership and the more members we get in the better it will be, and there is practically no limitation in the eligibility of members, except if they desire to become members, that they have interest in the purposes of the Institute, and therefore I see no reason why we should not adopt the motion and extend the invitation to become members to all these gentlemen, and if possible get them to be members."

Mr. Channing's motion was then put and carried.

Votes of thanks were then extended to Mr. Wm. Kelly, "who has so well filled the position of temporary secretary to our convention;" to Mr. M. W. Burt "for the able manner in which he presided over the convention;" to Mr. Larsson and Dr. Hulst for their interesting papers; to the Chicago & Northwestern Railroad, for putting at our service gratis special trains; to the reception committee and mining men of the Menominee district, "who have spared no effort to make our visit both enjoyable and profitable."

Meeting adjourned.

EXCURSIONS.

The following program of visits and excursions was arranged and carried out by the local committee on arrangements with perfect success, and to the enjoyment of all those who participated in them.

Thursday, March 23—The forenoon was spent at the Chapin, Lindington and Hamilton mines, inspecting the surface works, pumping and hoisting plants; special attention being given to the large steeple compound Cornish pump of the Chapin, and the flat rope hoist of the Hamilton, which at the time of the visit was being used in bailing the water from the mine.

In the afternoon a special train carried the party to Norway and Vulcan, where the Aragon, Curry, West Vulcan and East Vulcan mines were visited, some of the party going underground at the Aragon.

Friday, March 24—The morning was occupied in a visit to the large hydraulic compressor plant at the Quinnesec Falls, and in looking over the surface arrangements at the Pewabic mine.

The party dispersed at noon.

SOFT ORE MINING ON LAKE SUPERIOR.

BY PER LARSSON, SUPERINTENDENT, ARAGON MINE, MICH.

“Soft ore” being a relative term, it is necessary to explain that in this paper reference will be had to the brown hematites and limonites of the Marquette Range, locally called “hematites” to the ores occurring east of the Menominee river on the Menominee Range, to all the Gogebic and Mesabi ores, and to the Ely group on the Vermillion Range. The ores occurring west of the Menominee river on the Menominee Range, may be as soft to drift in as some of the ores just mentioned, but they are tough and strong, and can be mined by methods prevailing in hard ore regions.

The methods of mining made use of in the Lake Superior soft ore mines are the following:

1. Stripping and open pit work.
2. Rooming with timbering.
3. Filling.
4. Caving.

STRIPPING AND OPEN PIT WORK.

Open pit mining has been used more or less on all the Lake Superior Ranges. The stripping has been done by pick and shovel, or by scrapers, and the ore has been hoisted by derricks, or over skip roads, built on the slope of the banks. As, however, the ore deposits on all the older ranges dip at angles over 45 degrees, almost without exception, the limit of open pit mining has soon been reached in each case. The discovery of the flat deposits of iron ore near the surface on the Mesabi Range has lately revived the interest in this method of mining, and it will undoubtedly be used there on a much larger scale than on the older ranges. Steam shovels and locomotives are already pressed into service for removing the earth from above the ore beds, and though the strippers have suffered a temporary set back, owing to the difficulties of operating the steam shovels in the frozen banks during the last severe winter, they will eventually prove that the “stripping proposition” is both

feasible and economical in the end. The question has been raised, as to the amount of surface that can be economically removed, and in answer to this question, I would state the proposition, as a basis for discussion, that where the volume of ore to be uncovered is equal to or greater than the volume of surface to be removed it will pay to strip.

ROOMING WITH TIMBERING.

The system of rooming with timbering has been more extensively used than any other in our soft ore mines. The general plan under this system is to mine out certain blocks of an ore body on a given level in advance of others, that are left temporarily for the purpose of supporting the rock walls. The relative sizes of these rooms and pillars vary greatly, but it is quite common to make the rooms from 20 to 24 feet wide, and the pillars somewhat less. The length of rooms and pillars is equal to the width of the ore body. The rooms are worked from the bottom to the top of each lift, and heavy structures of timber are built up in the rooms, as the mining proceeds upwards. In some of the larger mines, where this system has been employed, these huge underground structures of timber have collapsed under the pressure from the surrounding walls, and in such cases the rooming system has either been abandoned or materially modified. Such extensive caves have, of course, temporarily checked the output of ore, and the system itself has sometimes fallen into disrepute. But in cases where the size of the ore deposit is limited, it affords a possibility of a forced output, a fact that commends it to mine owners. The great cost of the heavy timbering that it requires is of course one of the greatest objections to it. This cost rarely falls below 25 cents per ton of ore.

THE FILLING SYSTEM.

Rock filling is often used in connection with rooming, in which case lighter timber can be used, or timbering entirely dispensed with. Where it is absolutely necessary to keep the surface above a body of soft ore from sinking, as for instance in a swamp, or under a town site, or under a main line of railroad, no other system than this combination of rooming and filling will answer the stated purpose as well. But such cases are not very frequent. The instances in ordinary mining practice, where rock filling is most economical

and advantageous, are those where the filling material can be put into the desired place without the use of a shovel or, in other words, where it is not required to put in the filling close up to the back of the stope. Such a case occurs in the Chapin mine, where on the lower levels the ore is of sufficient firmness to hold up without the use of timber in twenty foot rooms carried across the whole width of the ore formation. Here the stopes are taken nine feet high, and the rock filling is dumped by small cars to within four feet of the back, after the completion of each stope.

Other cases where rock filling is used are those, where narrow deposits of ore can be mined longitudinally with stopes reaching from foot to hanging wall. In such cases the rock filling is kept pretty close after the miners, unless the hanging wall is firmer than we usually find it in soft ore mines.

The system of filling introduced eight years ago into the Chapin mine, whereby the whole ore body in each lift was mined by slicing the ore out floor after floor from the bottom up, and by filling each slice close to the back with rocks has been abandoned, on account of the great expense of shoveling filling into the stopes, and the high cost of the necessary openings.

CAVING.

Two distinctly different applications of the caving methods are now used on Lake Superior. In the one the miners commence stoping at the top of a lift, and are always working under a "gob" roof, while in the other they attack the ore at the bottom of a lift, and work under a crumbling block of ore, which keeps sinking down to them. The former method has long been employed in European soft ore mines, especially in the north of England, and it has been in use for a number of years in this region, while the latter is a new method, adopted on a large scale one and one-half years ago in the Chapin mine. The former is well adapted to such soft ground, where the ore can be mined chiefly by pick and shovel, while the latter can be used in quite firm ground, which breaks up more or less in settling, before it reaches the miners, the bottom floor alone being in its natural solid state when mined. The north of England system has the advantage, that it can be used in irregular ore bodies without danger of leaving behind off-shoots from the

main body. When it is desired to use the Chapin system in relatively flat or irregular ore bodies, it becomes necessary to make the lifts short. In such cases it may be found advantageous to use a modification of the North of England system, such as is now successfully employed in the Chandler mine, where each lift is mined from the top down, but each floor is taken fifteen feet thick. Other applications of the caving system may be seen in the Norrie and Lake Angeline mines, where, on the new chamber and pillar plan, the ore is mined in vertical sections from the hanging to the foot wall, and the hanging wall rock or overlying "gob" is caused to run into these sections as they proceed towards the foot.

In conclusion, it may be said that the conditions, that meet the miner in the different mines are so varied, that no two mines can be worked by exactly the same plan. Such of us that have had pet methods are fast giving them up. Those that have advocated filling may occasionally find it to their interest to cave, and those who are professional cavers are sometimes found to be engaged in rooming. And we would perhaps all be only too glad to join our Mesabi friends in adopting their "stripping proposition," if nature had not turned our ore deposits edgewise in the ground. We must, however, adapt ourselves to the conditions that meet us, and by learning from each others' experience, endeavor to keep ourselves to the front among American miners.

DISCUSSION.

MR. JAS. KNIGHT—Mr. Larsson has made the statement that if the body of stripping is not larger than the body of ore, which may be any length, that it would be well to strip and it would seem that that would depend materially on the width of the ore body. For instance, if you were to have thirty, forty, fifty or sixty feet of stripping, it would be necessary for you to slant your walls, and your stripping would be greater for a narrow body of ore than it would for a wider, and it would seem that that proposition should be qualified some.

MR. LARSSON—I will change, then, the expression from uncover to remove.

J. PARKE CHANNING—I would like to challenge Mr. Larsson's statement in reference to what he calls the North of England caving

system, by which is meant going to the top of the ore body, and taking the slices from the top and working down. He claims that one advantage is, that it prevents the loss of parallel ore bodies. That is, that in going down you are not liable to leave any ore bodies behind. I think you are particularly liable to leave some lateral ore body, and therefore I would ask Mr. Larsson if he can explain, in a system of that kind, how that would be avoided. We will suppose for example that there is an ore body like my hand—here is a cross section (indicating by holding hand up). Now there is an off-shoot from that body, which rises in the position of my thumb, and I put a raise up in the main body represented by my closed fingers, and I strike the “gob” and am working down, and when I get here (base of the thumb), I discover that my ore is wider. I may have caved in a portion of rock, which is here (indicating) between the main body and off-shoot, and the off-shoot is a loss as I cannot mine it.”

MR. LARSSON—“I will say that there may be some loss of that ore, but it seems to me that if the ore body has that shape you can put a raise in this off-shoot, and mine it down. It may be mixed some with the rock.”

MR. CHANNING—“You don’t explain the possibility, which certainly may arise, by supposing that the extra ore body may be on the side. I know of a case in the Norrie mine, where the ore body is separated towards the hanging by a horse of rock, and if that principle of the North of England system were used, the hanging would cave over, and the ore body would be lost.”

MR. LARSSON—“I will say I think there may be loss, but probably the reason why the system was adopted was because, on the whole, it was found to be the most economical, and the superintendent or mine owner was compelled to adopt it. And he must run the chance of losing some little ore in such off-shoots. Still I do not think that such cases are very frequent. I think the rock mixes less with the ore than is generally supposed, and that such off-shoots can be mined separately.”









MR. CHANNING—“Might it not be better to make that statement used in relation to the North of England system, to refer to the other system, which is called the Chandler or Brotherton system, that is in taking the main lift, and dividing it up in four or five

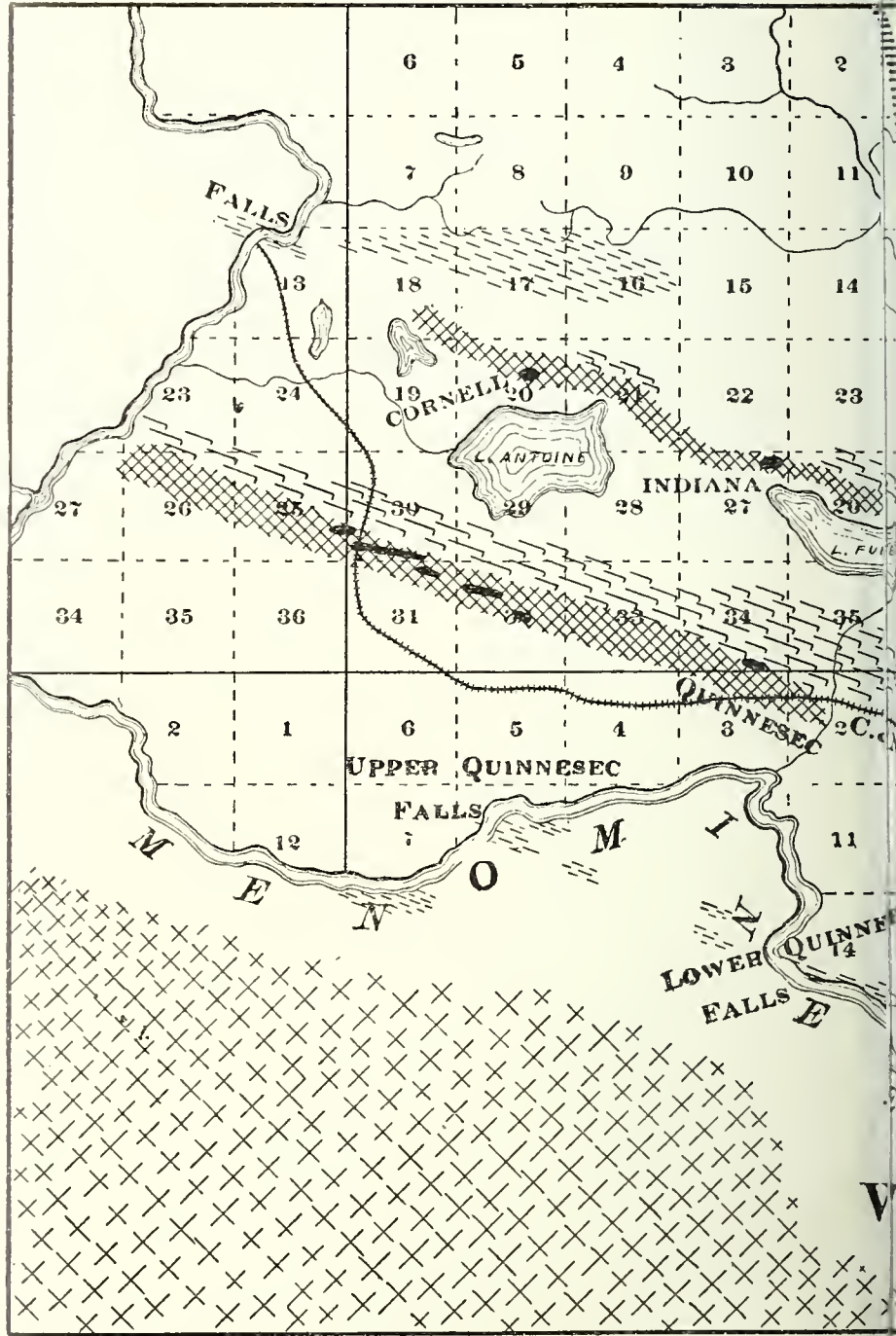
sub-lifts through which the sub-drifts run. In that case, it will be much more advantageous, while you are going up, to do a certain amount of exploring by these sub-drifts, to remove a certain portion of all the ore bodies and so to determine their condition. When you get down to the level with the top of a side body of ore in your stripping, you would go over to the side body, and strip that down. We must admit that the North of England system is applicable to certain kinds of ore bodies. There are cases where the sub-drifting system would work much better. Each individual mine represents as you have said a problem which must be worked out itself, and the man is foolish who sticks to any particular kind of his own."

MR. LARSSON—"I think that covers the point which I made. I don't advocate the North of England system. If the Chandler system is better, I would use that."

Faint, illegible text covering the majority of the page, possibly representing a list or a series of entries.

MENOMINEE RANGE

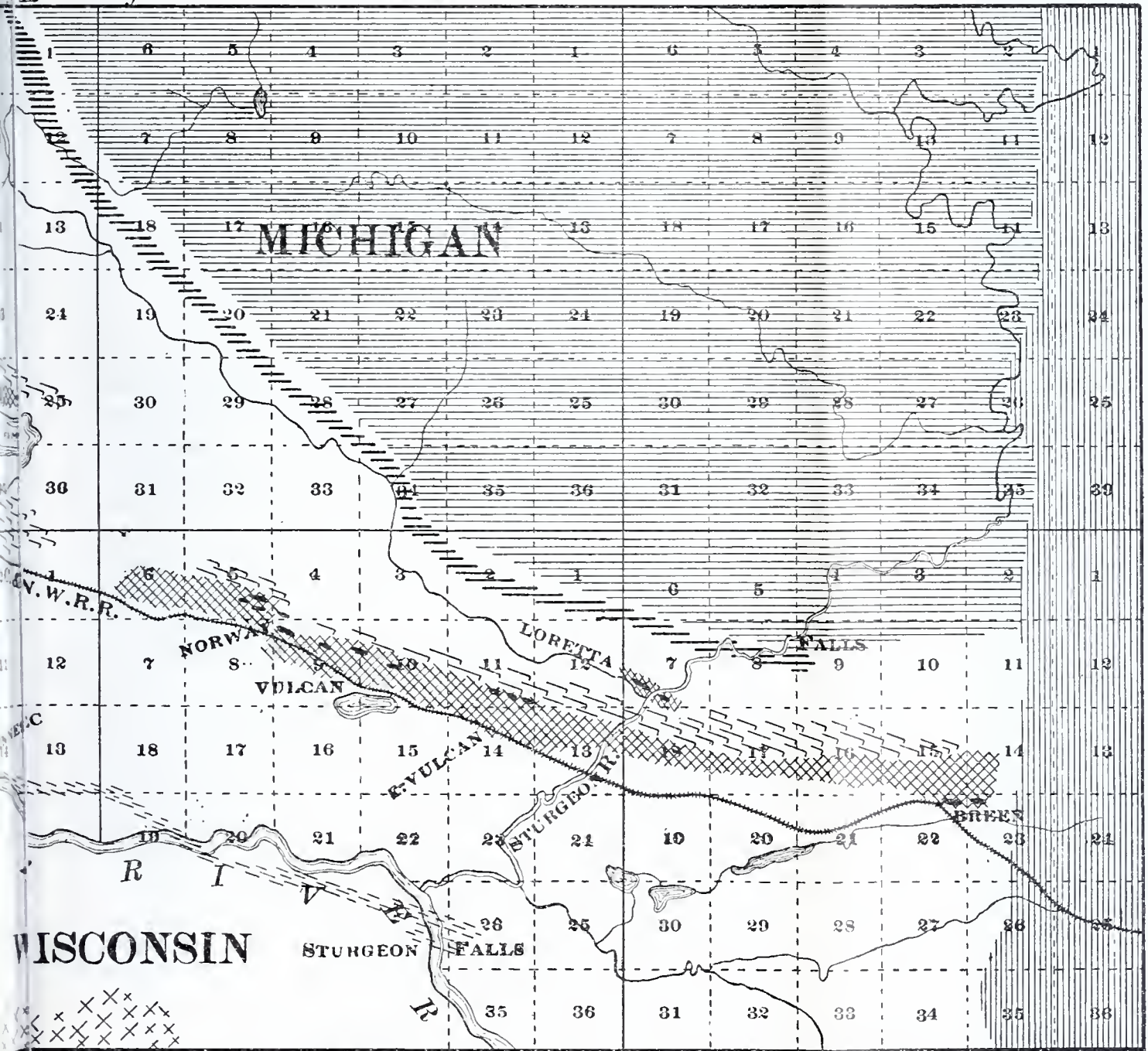
- LAURENTIAN 
- SILURIAN 
- QUARTZITE 
- LIMESTONE 
- HCR. GRANITE 
- GREENSTONE 
- BANDED IRON ORE 
- IRON MINES 



R-31

R-30

East Of The MENOMINEE RIVER



T-40

T-39

R-29

R-28

THE GEOLOGY OF THAT PORTION OF THE
MENOMINEE RANGE, EAST OF THE
MENOMINEE RIVER.

BY NELSON P. HULST, MILWAUKEE, WISCONSIN.

The portion of the Menominee Range lying east of the Menominee river has a length of about nineteen miles. It is marked throughout by elongated hills. At the eastern limit near Waucesah they have but a moderate elevation. They trend in a northwesterly direction, and gain gradually in elevation, until near the western limit, where they are diminutive mountains. It is in part a dual range, as folds in the same rocky strata produce a shorter range of lofty hills, which lie parallel to and some two miles north of, the other. This shorter range stretches across the entire township of forty (40), range thirty (30). From the nature of the rocky strata, which are found capping the summits of all the hills of both these chains which we call the Menominee range, it is evident that in the ancient geological period when they were formed, they were beneath the ocean of that time. They are accounted the earliest of the silurian rocks, and they comprise heavy beds of stratified sandstone and overlying limestone, each hundreds of feet in thickness. By the fossils which they contain, ample proof is afforded that they were once submerged. At the eastern limit of the range, we find this sandy silurian limestone below the level of the railroad track. It has an elevation there of three hundred and fifty-two feet above Lake Michigan. The same limestone caps the lofty hills near our town, where it has an altitude of eight hundred and fifty to nine hundred feet above the lake. As is evident, the whole region has been uplifted at some remote period, and this uplift has been greater as the distance from the lake increases. Only here and there are there any patches of the silurian rocks, the sandstone and the limestone, now to be found upon the range. When these sedi-

mentary rocks were laid down over the ocean floor, it is not to be doubted that they formed continuous beds over vast areas. They are known to exist as such today in various regions of the earth. Succeeding this rock formation then, came the uplift mentioned, which elevated them to the altitude they now have, so far above the lake level. A period of glacial action followed, when streams of ice plowed southward over this sloping expanse of silurian rock. They, perhaps, almost covered the rocks, as with an ice cap. They scored out great valleys, and so complete was the wreck they made of the extensive beds of sandstone and limestone covering the region, that only a few small areas of them are left to tell the story. Underneath these old silurian rocks along the Menominee range, we find still other rocks. They are readily conjectured to be older than the silurian, because they are tilted at a high angle, and were in this position when the sandstone and limestone were deposited on their upturned edges. These still older rocks were many of them sedimentary. Certain of them have been grouped together as the product of one period, because of parallelism of stratification. To this group the name of the Huronian system has been assigned by geologists. Another group of neighboring rocks, unconformable in stratification to the Huronian rocks, is considered a still older series. These latter are called Laurentian rocks. They are esteemed the oldest known rocks, and are found to cover a considerable area but a few miles northeast of Iron Mountain. So we have here in our vicinity a portion of the backbone of the continent. For the most part the Menominee range proper has its limits within the area of the upturned Huronian rocks. A belt of more or less silicious limestone is one of the most resisting members, and hence this is to be found as the axis of the range. If we could see these Huronian strata denuded of the remaining portions of the horizontal beds of sandstone and limestone, and their covering of gravel and drift material, we would find a very rugged topography. At the Pewabic mine, just a mile east of the notable Iron Mountain gap, we would discover a narrow gorge quite three hundred feet deep, a great chasm having its bottom quite as far below the main street of Iron Mountain, as that street is below the summit of Ludington mountain. In the prosecution of mining work at the Pewabic, the silurian sandstone regularly bedded was found at that

depth. The rock formations of this Huronian period are found very various in character. They vary as well in thickness. They are not all of them persistent. Some of them thin out and cease to exist, being replaced by other rocks, as the conditions governing their deposition change. We get a good knowledge of the various rock formations of the Huronian in this region, if we examine the list of rocks reported to outcrop on a line reaching from the Laurentian rocks near the falls on the Sturgeon river, southwesterly to the Huronian granite. We have such a record in the Michigan Geological reports, giving the series as follows:

1. Schistose rocks, reddish quartzite, schist conglomerate and greenstones, about 300 feet thick; some geologists group these with the Laurentian rocks.
2. Quartzite, at least 1,000 feet.
3. Iron ore, ferruginous and clay slates full 1,000 feet; the horizon of the Loretta mine.
4. Limestone, 1,700 feet.
5. Iron ore formation, 700 feet; the horizon of the mines from the Breen to the Ludington.
6. Kanbury slates, 1,000 feet.
7. Chloritic slates.
8. Quartzite.
9. Chloritic slates.
10. Ferruginous slates.
11. Greenstones of variable composition.
12. Granite.

} A total of perhaps 10,000 feet.

South of the Hanbury slates the drift material covers a considerable portion of the rock series. Its depth increases in the valley of the Menominee river, and in consequence only occasional outcrops of the much varied greenstone formation are to be seen.

It is this particular rock of the Huronian series which obstructs the Menominee at Sturgis Falls. It may be said that all the falls and rapids of the river, far below Sturgeon Falls, and up stream as well, to the point where the Menominee Range crosses the river, and even beyond, are due to this rock in some of its varied combinations lying across, or along the stream bed.

Both the lower quartzite and the limestone, where they are not covered by the horizontal silurian rocks, are prominent outcrops.

Their resting qualities made them a strong barrier against the powerful denuding forces of the pre-silurian and silurian times. Even today, after untold ages of weathering, one can find the edges of quartzite strata outcropping at the Falls of the Sturgeon, as sharp as though the strata were fractured but yesterday.

The Huronian strata are estimated to have a total thickness here of some fifteen thousand feet, without including the eruptive granite, which is assigned to this period. These sedimentary rocks were all formed below the level of the Huronian ocean, and this ocean had as its bed the older Laurentian rocks. The Huronian sedimentation had them for its foundation. After long ages this rock series was completed, and then there came again periods of uplifts and foldings of the crust of the earth. Measuring south from the Laurentian field to the eruptive granite, we have a linear distance of nearly thirty thousand feet. Wherever we find the Huronian rocks in this region they are seen to stand on edge, or to be tilted at a high angle. From their original horizontal position we see that they have been crumpled into waves, and doubled back against themselves by some irresistible force. This plication of the rocks into such close folds makes many repetitions of the strata probable, and such are observed at several points. Such foldings are reckoned to account for the apparent difference between the estimated thickness of the Huronian series of rocks, and their actual thickness in the distance mentioned. Just north and east of Quinnesec such a folding is represented to exist in the limestone belt, which would account for the unwonted thickness of this rock at this point. There are evidences of other folds of these rocks on a grander scale. We find the lower quartzite, and the series above it, slanting up against the south boundary line of the Laurentian rocks. Likewise on the northern limit of the Laurentian area, which is some six miles wide, we find the same Huronian rocks lying up against these oldest rocks. They dip to the north and the order of the series is the same. We find the quartzite at the bottom, then an ore bed, then limestone, etc. The natural inference from such facts is, that some great uplift has elevated them, bringing the lowest member of the series, as well as the underlying Laurentian rocks, far above the ocean level. The once continuous overlying Huronian rocks, had they remained in place after the uplift, would have made a lofty, precipitous mountain, at least three miles high. It has all

disappeared, leaving only its foundations to attest its magnitude. There have been other lesser folds of these same rocks along the range.

Referring to the map, the principal rock formations of the range, which enlist our attention, are there indicated. The quartzite shows its first outcrop near the falls of the Sturgeon, and is seen to reach off northwesterly. It follows the contour of the south and southwest boundary line of the Laurentian area. The limestone is seen to appear north of the Breen mine, and it takes a course more westerly than the quartzite. At the western limits of this portion of the Menominee range, which we are considering, it is seen that the two formations, the quartzite and the limestone, are widely divergent. Intermediate between them there are found outcrops of highly tilted limestone and quartzite, which indicate that another fold exists between the belts of quartzite and the limestone first traced. This intermediate fold has its southerly sloping limestone belt lying back of the old Indiana mine, northwest of Lake Fumee, and it continues probably north to the Cornell mine. These divergent folds may be likened to those of a lady's fan.

As one follows along the trend of the Huronian rocks, he notes that at the Breen mine, the easterly end of the range, the dip of the strata is invariably to the south. It should be remarked here, that the Huronian rocks are not supposed to cease existence at this point. They only disappear from vision, being covered by the later Silurian rocks, which from here eastward to the shore of Green Bay, form an unbroken sheet. As just stated, the dip of the rocks observed at the Breen mine is southerly. The quartzite and the limestone, also as seen at the Sturgeon river, just north and west of the Breen mine, show a dip to the south. The Loretta mine, and its accompanying slates, dip the same, and pass under the limestone. The ore of all the mines, as well as their enclosing strata, as far west as the Norway mine, have a positive southerly dip. So, too, in the extensive prospecting, which has been carried on westerly from Norway to the west side of section six (6), township thirty-nine (39), range twenty-nine (29), the rocky strata have a south dip. From this point we pass over a gap of two miles to the Quinnesec mine. Here the dip of the ore formation, as well as that of the accompanying slates, is strong to the north. The more or less continuous exploration extend-

ing west from the Quinnesec mine to the Keel Ridge mine, shows a northerly dip of the strata. In the shaft sinking at Keel Ridge, the dip of the strata near the surface was slightly to the north; at a greater depth the strata changed to a positive south dip, and all the cross cutting at the three hundred and eighty foot level of the mine passes across southerly dipping strata. At the Pewabic mine, west and north of Keel Ridge, we have sunk in the red slates five hundred feet through southerly dipping strata. A crosscut at a depth of three hundred feet in the slates, passes through fourteen feet of southerly dipping strata, reaching to the limestone on the north. At the Walpole, Millie, Chapin, Hamilton and Ludington mines the dip of the ore bodies, as well as that of the enclosing slates and the contiguous limestone, is to the north. Making a summary of these facts we see that for eleven or twelve miles on the eastern end of this portion of the range, the dip of the south series of the Huronian rocks is to the south. For the remaining five miles of the range, adjoining and to the west, so far as it has been exploited by mines, the same series shows a dip in part to the north.

Which can be considered the correct one? There are weighty reasons for thinking that the true dip is a south one. If we go back to the cross section of the Laurentian and Huronian rocks near the Sturgeon river, we find the lowest members of the Huronian series lying against the Laurentian and dipping south. Looking for the cause of this great Menominee uplift, we see it in the vast area of eruptive granite, many miles in length and breadth, lying a few miles to the south. Its superincumbent weight was so enormous that the Huronian strata over which it flowed sunk beneath it. This subsidence was equalized or compensated by a thrusting up of the Laurentian rocks, and with them the Huronian strata superposed upon them. The Huronian rocks, on the south side of this Laurentian area so uplifted, must of necessity dip to the south, and we so find them. The quartzite, and the great belt of limestone at the Sturgeon river, are seen there to have a southerly dip. The ore belt and the enclosing slates succeeding it (i. e.), lying above it, likewise have a south dip. It is without question, that this ore belt is the same throughout the length of the range. The unproven portion of it extends from section six (6) township thirty-nine (39), range twenty-nine (29), to the limestone outcrop



PEWABIC MINE

SCALE 100 FT. TO 1 IN.

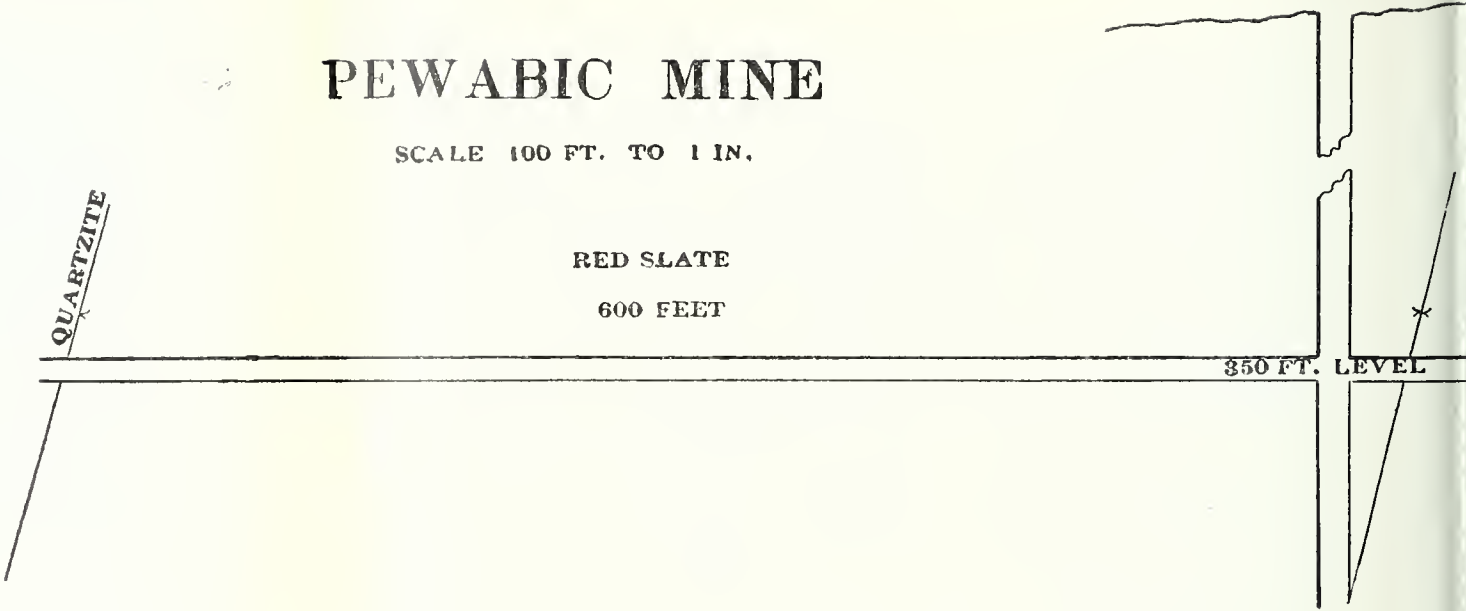
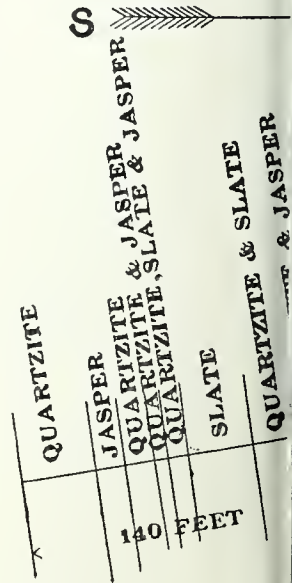
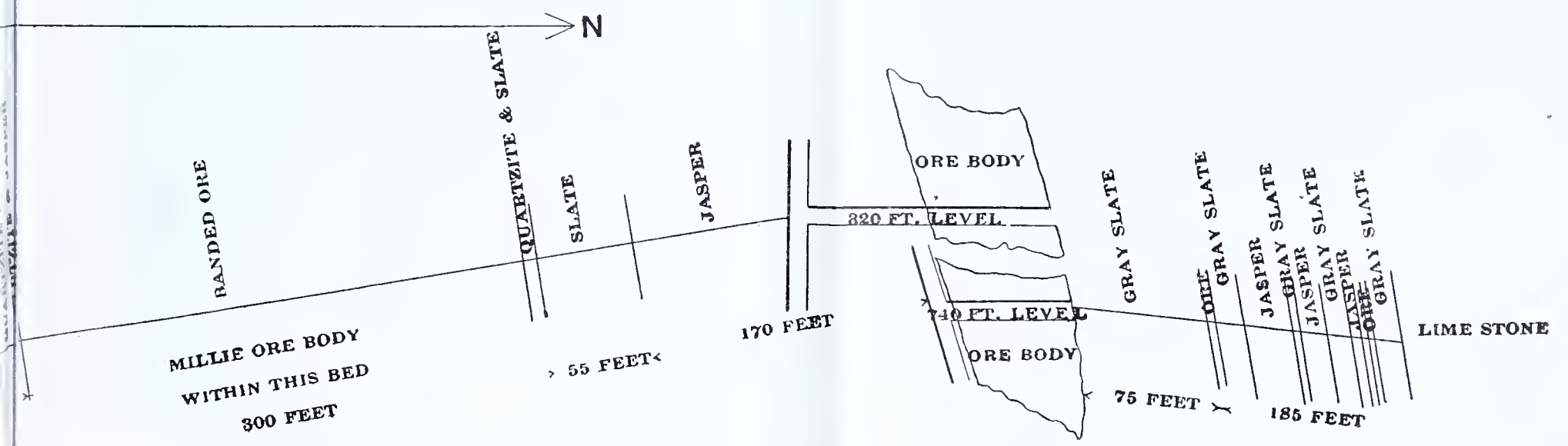
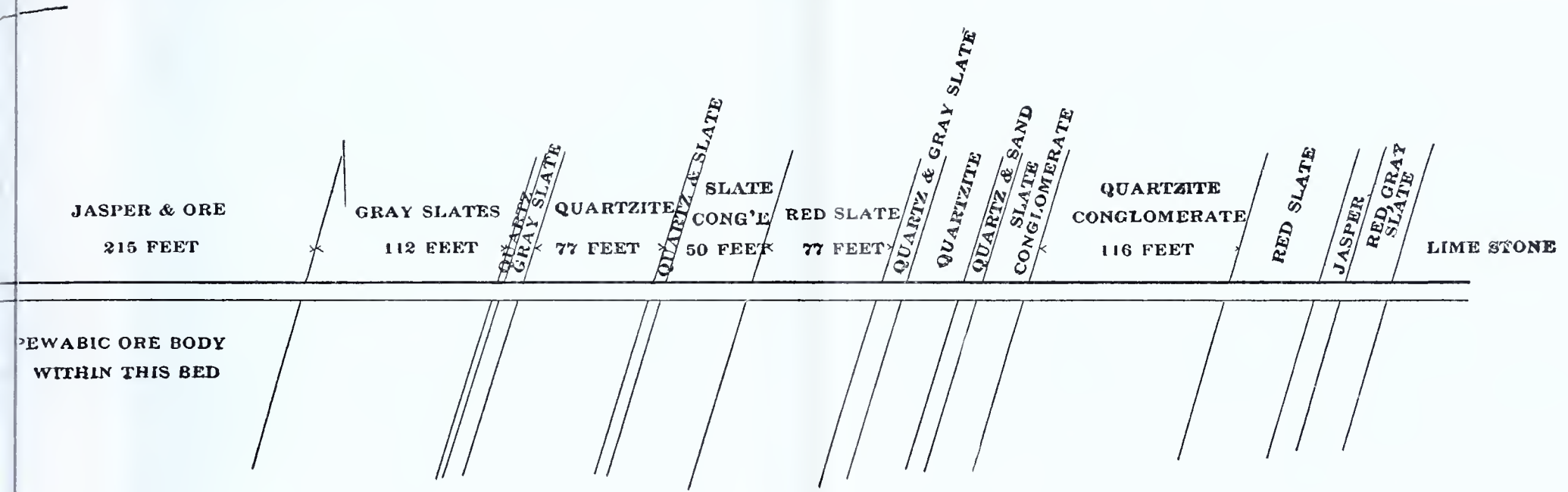


FIG. 1

CHAPIN MINE

SCALE 100 FT. TO 1 IN.





re,
ge,
t a g
erc
ine
anc
tth
hu
y d.
Wa
f t
nti
fac
s po
cks
djo
he s

weig
f wa
n re
of
sou
ee it
reac
wa
l su
l b
ron
sou
dip
t be
cherl
. e.)
stio
an
n ..
terc

east of Quinnesec. Its continuity cannot be doubted. In the facts given, there would seem to be strong evidence, that the dip at Quinnesec, as well as at the Chapin and the adjoining mines, is an inverted or overturned one. Corroborative evidence was noted by the late Charles E. Wright, in the water-worn boulders of limestone, which he found in the Chapin mine workings at the junction of the slates and limestones.

Until recently, the productive mines of this eastern portion of the range have all been found in the wide belt, directly south of the limestone.

This lean jaspery ore formation is itself made up of many members, which vary indefinitely along the length of the range. Beds of red slates, quartzite and gray slates, are intercolated between several belts of lean jaspery ore. It may be said, that the red slate and gray slate formations are more persistent than those of the quartzite. The gray slates are found quite uniformly nearer the limestone. South of the most southern lean ore formation we have red slates, which gradually change to those of a mottled, lighter color.

There are given in Fig. 1, cross-sections of the Pewabic and Chapin mines. Being drawn to the same scale, a ready comparison can be made, of the location of the two ore bodies with reference to the same limestone formation. The Chapin mine lies in a bed of lean banded ore about 200 feet south of the limestone. The Pewabic mine lies in a similar bed of banded ore, which is 700 feet south of the limestone. It is probable, if not certain, that these are two different beds.

Immediately south of the lean banded ore containing the Chapin mine, is a bed of red slate thirty-three feet in thickness, where the foregoing section was taken. Next south of these slates is a bed of lean banded ore 300 feet thick. This, probably, is the bed enclosing the Millie ore body, and which extended easterly contains the Pewabic ore body. South of this formation at the Pewabic mine lies a great body of red slates 600 feet thick; while south of this supposed same formation of lean banded ore as given on the Chapin cross-section, eight different beds of quartzite, slate and jasper, or banded ore occur, having a total thickness of 140 feet. Quite probably red slates would have been encountered had exploration

work at the Chapin mine been continued farther south. At Norway, Quinnesec and Iron Mountain, the width of the ore-bearing formation has been proven to be at least fifteen hundred feet wide, measuring south from the limestone. Within this width, along the entire portion of the range under consideration, the beds of lean jaspery ore are variable in thickness; only here and there do they include bodies of merchantable ore. About Norway and Vulcan extended mining work has developed several quite closely associated ore bodies. At East Vulcan a smaller group of ore bodies is found, while a third group may be found at Iron Mountain.

Thus far in the history of the development of this portion of the range, it appears that its productive portions are to a certain extent located at, or near points, where the geological formation has been faulted, eroded deeply or sharply folded.

At Iron Mountain a great gorge has been eroded through the Huronian ridge, which once was continuous from mountain to mountain.

At the Pewabic mine a gorge, double the depth of the Iron Mountain gorge, exists in the Huronian strata, and the evidence exists of one, if not two faults or sharp folds of the same strata, at no great distance from the Pewabic ore body.

At Quinnesec likewise the broken trend in the outcropping limestone is evidence of a fault or similar sharp fold. So, too, at Norway, the apparently displaced limestone ridge, and lack of continuity of the ore formation, are indications of a fault or sharp fold.

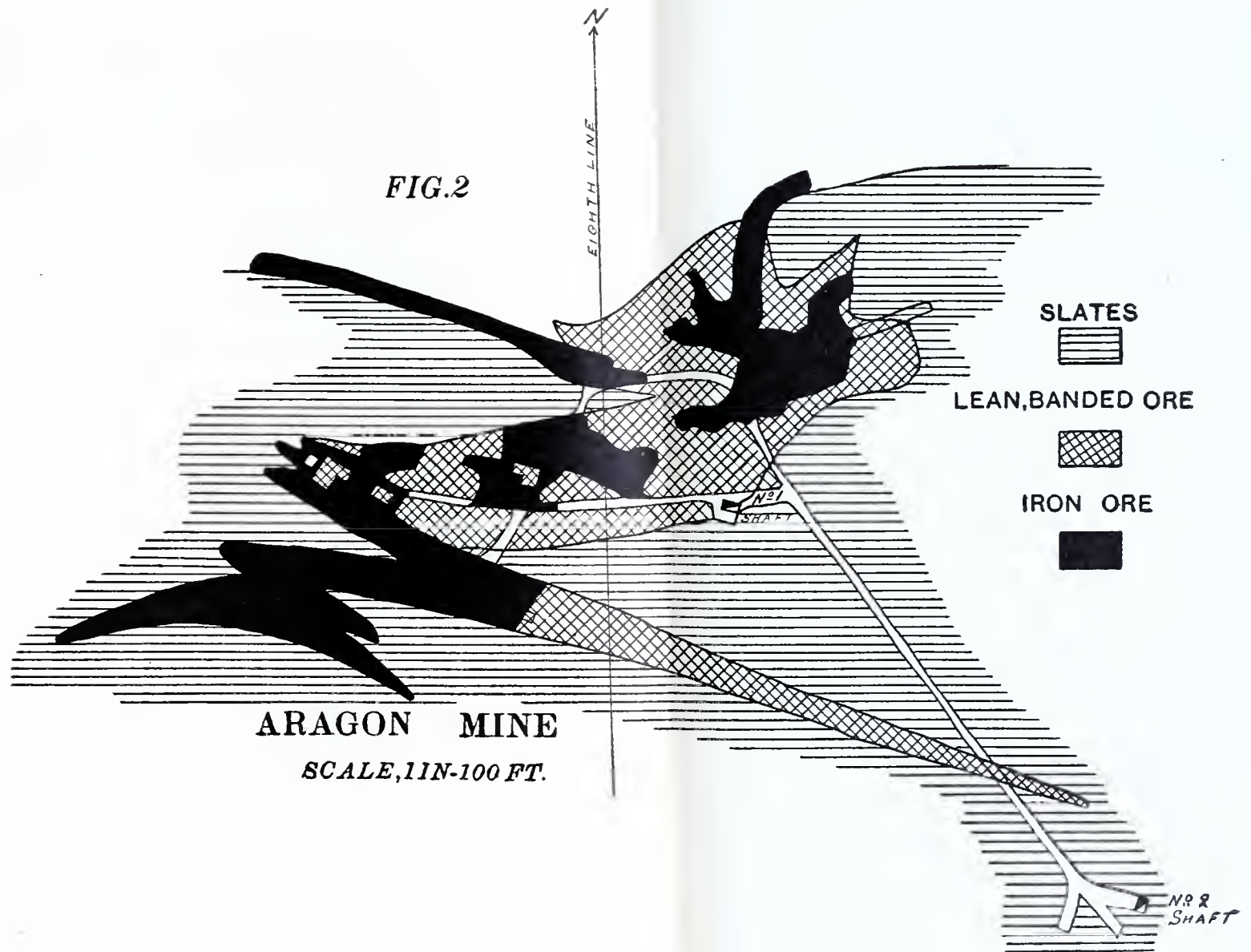
The Aragon mine lies near the line of this fault or fold, and its disturbed ore body and enclosing slate rocks, as shown in Fig. 2, bear witness to the stress at this point.

These coincidences, which I have related, may be that of mere chance, but they are at least worth consideration in the search for ore along the range.

The ore bodies, as has been stated, are found in beds of banded lean jaspery ore. The lean ore is the invariable associate of the richer ore. There may be larger lenses of ore, as for instance the large lense of the Chapin mine, widening out to reach the enclosing slate walls on either side, but in its extension longitudinally the ore body diminishes, and lean ore fills up the width.

The rich merchantable ore often appears to be part and parcel of

FIG. 2



the general stratification of the lean ore encompassing it. Not infrequently, one finds spots in the ore bodies, where the ore is apparently in the transition state from jaspersy lean ore, as though the ore body were charged with a solution, which was gradually dissolving out the silica from the adjacent enclosing jaspersy ore. Quite invariably there is a notable pitch to the ore bodies, and with rare exceptions this pitch is to the west at a variable angle of from thirty to fifty degrees. If, as is probable, the ore bodies were formed before the uplifting of the Huronian rocks, it may be possible to account for the pitch, by stating that the axis or line of the uplift made the same angle with the axis of the ore bodies, as the axis of the ore bodies do now with the horizon. That is, the ore bodies, which now pitch northwest, had, when lying horizontally, a south northwest trend; while an ore body pitching northeasterly like the Pewabic had, when lying horizontally, a south northeast trend.

It was supposed well settled, until within a few months ago, that the only ore formation giving any promise of productive ore bodies, must lie above the limestone geologically. A good deal of energetic exploring was done in the early days of the range on the slates and banded ore lying north of the Norway mine, and underlying the limestone.

Our present mineral commissioner bought expensive experience in that horizon. And the Menominee Mining Co., at the same early date, struggled ineffectually to reach the supposed ore belt underlying the deep drift near the mouth of Pine Creek on Section 2. Now that the Loretta mine has been found underlying the limestone, and producing ore of a high grade, our range has new possibilities.

It might be remarked here, that this mine is in close proximity to a gorge in the Huronian strata, making one more link in the chain of coincidences of which mention has been made.

Within a brief period, a bed of merchantable magnetic ore has been found by diamond drill exploration to exist near Quinnesec.

This deposit lies south of the formation of banded jaspersy ore, apparently by itself, though it is in the line of a well known magnetic attraction, which skirts along the base of the range for its entire length.

Substantial measures were undertaken to open up this new find of

ore, but the promoters of the enterprise have contracted a severe form of the Mesabi fever, which promises to run a long course with them.

Without exception, all the merchantable ore of the range is found lying in the more or less extensive beds of lean ore. The lenses are likely to be found in any portion of any of the beds, from the bottom to the top of the beds geologically speaking. To some of the beds well defined hanging or foot walls of so-called soapstone or soap rock may exist; to others there are no walls, the merchantable ore suddenly giving away to the lean ore, or vice versa, according to no rule. When there are no well defined walls found accompanying the ore body, such lenses of ore are quite sure to carry a minimum per cent of phosphorous. The Millie, Pewabic, Cyclops, Aragon and S. E. Vulcan mines, are all notable in this respect. All of the mines east of the Menominee river at the outset, except the Norway, the Stephenson and the Perkins adjoining, were producers of low phosphorous ores. Some of them still continue so. It would appear that the ore, immediately underneath the drift covering, has had more or less of its phosphorous leached out by percolating waters. That the phosphorous does leach out, during a winter's exposure on a stockpile, is a well settled conviction, with the chemists who have worked upon the Menominee blue ores.

It is a notable feature of this portion of the Menominee range, that all of its mines with the exception of the Norway, produce the well known soft blue hematite. They are in fact soft specular ores. With other ore ranges, and also with the western portion of the Menominee range, a mine producing ore of such color and texture is the exception. Here, it is the rule, and yet there is an individuality with the ore of each mine. With a little practice one could almost unhesitatingly select and name the ore of each mine, in a selection of typical samples.

In concluding, a word should be said about the limestone which occurs in such abundance. It is a pure dolomite, and often workable thicknesses are found, which contain but a slight percentage of silica. An lyses by Mr. Brewster of average samples of the limestone taken from B shaft at the Chapin mine when sinking, and from other points gave:

	B Shaft Chapin.	Hamilton Shaft Rock Pile.	D. Drill Core Chapin.
Carb. Lime.....	53.31		
Carb. Magnesia.....	43.00		
Met. Iron.....	.80		
Silica.....	.73	3.60	1.53
Alumina.....	.20		
Phosphorus.....	.022		

There are several points in this vicinity where it can be cheaply quarried or mined, and when that good day arrives in which lean ores are marketable, those of this region will have an added value because of so convenient and valuable a flux.

